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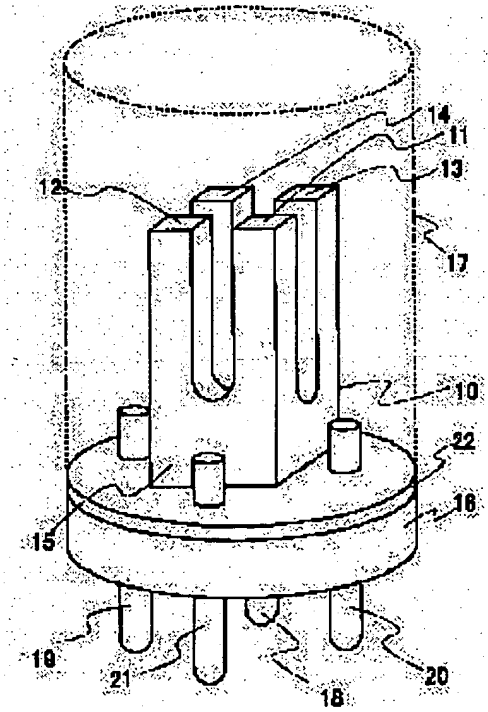
(54) **VIBRATION GYROSCOPE**

(57)Abstract:



PROBLEM TO BE SOLVED: To increase detection sensitivity and to improve detection accuracy by good symmetrically arranging four legs into a two by two square shape, and keeping a base section nearly stationary at any vibration.

SOLUTION: A base 16 is made of an insulating material such as a ceramic, and a wiring board 22 is stuck to its upper face. The base section 15 of a quartz quadritine tuning fork vibration gyroscope 10 is stuck and fixed to the wiring board 22. The base 16 fixing the quartz quadritine tuning fork vibration gyroscope 10 is sealed by a metal cap 17, and the internal environment is kept constant. Each leg is made of a quartz having elasticity and a piezoelectric property, and it has an electrode made of metal deposition film applied on the side face of a square column. The first through fourth legs 11-14 are arranged at the positions of four apexes of the square base section 15 in parallel with each other, and the base section 15 and the first through fourth legs 11-14 are integrated. Since four legs 11-14 are good symmetrically arranged, the base section 15 is kept stationary at any vibration, the gain in the resonance detecting direction can be made large structurally, the output other than Corioris force can be canceled, thus noise is reduced, and a high S/N ratio is realized.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the oscillating gyroscope which detects angular velocity.
[0002]
[Description of the Prior Art] Although the mechanical rotation gyroscope is used as inertia NAV equipment of an airplane or a vessel from the former, equipment is large and it is difficult to include in electronic equipment with it, or a small transportation machine. [a high therefore price and] [small]
[0003] However, an oscillating object is excited also for a gyroscope with piezoelectric ceramics by research of a miniaturization progressing in recent years, utilization of the oscillating gyroscope detected with another piezoelectric ceramics which prepared the angular-velocity current generated by vibration which breaks out by the Coriolis force which an oscillating object receives by rotation in the oscillating object progresses, and it is used for the navigation system of an automobile, the hand deflection detection equipment of a video camera, etc.
[0004] The conventional gyroscope which used piezoelectric ceramics is explained using a drawing below. Drawing 13 is the perspective view showing the oscillating gyroscope of the conventional tuning fork mold.
[0005] Drawing 13 explains the oscillating gyroscope of the tuning fork mold of the conventional technique. The oscillating object 71 has the structure of the compound tuning fork mold formed by iso-elasticity alloy, such as an elinvar. That is, the oscillating object 71 has the structure which combined the 2nd guide peg 74 and 75 in the upper part of the 1st guide peg 72 and 73 of a tuning fork. The mechanical component and the drive electrode 76 made from piezoelectric ceramics make the 1st guide peg 73 have rivaled. Although not illustrated, the same mechanical component and the drive electrode make the 1st guide peg 73 have rivaled. The detecting element and the detection electrode 77 made from piezoelectric ceramics make the 2nd guide peg 75 have rivaled. Although not illustrated, the same detecting element and the detection electrode make the 2nd guide peg 74 have rivaled. Here, the direction where the guide peg was extended is made into the direction of the z-axis.
[0006] The operation based on a configuration is explained above below. The 1st guide peg 72 and 73 generates the 1st crookedness vibration displaced right and left with the alternating voltage impressed to the drive electrode 76. It is called in-plane vibration from the practice which makes it an ideal below for the usual tuning fork to vibrate this in one field. By this in-plane vibration, in-plane vibration of the 2nd guide peg 74 and 75 combined with the 1st guide peg 72 and 73 is carried out. If the whole tuning fork is rotated with angular velocity omega around the z-axis, Coriolis force Fc will work in in-plane vibration and the right-angled direction. Coriolis force Fc can be expressed with the following formulas. Fc=2 and M-omega-V -- here, M is the mass of the 1st guide peg 72 and 73 or the 2nd guide peg 74 and 75, and V is the rate of vibration. By this Coriolis force Fc, in-plane vibration and the 2nd crookedness vibration displaced in the direction of a right angle are excited. This is called out-of-plane vibration below. Angular velocity omega can be computed and known by detecting the alternating voltage

generated by this out-of-plane vibration with the detection electrode 77.
[0007]
[Problem(s) to be Solved by the Invention] However, there are the following problems in the conventional oscillating gyroscope. When supporting an oscillating object generally, in order to make for the effect of support to attain to an oscillating object into the minimum, the knot of the location which is not moved while an oscillating object vibrates, i.e., vibration, is used. Although the knot of in-plane vibration is in the part of ** and this circumference is hardly moved by the configuration of the tuning fork mold shown in drawing 13 , the part which does not move by vibration does not exist in the out-of-plane vibration excited by Coriolis force. Therefore, however it may support which part, the effect of support will attain to an oscillating object.

[0008] Although tuning fork mold vibrator generally supports around the center section of **, compared with the resonance frequency of the in-plane vibration of the oscillating object 71 hardly changing, there is change of the resonance frequency which reaches also to several% by out-of-plane vibration by the case where it does not actually support with the case where this part is supported. Therefore, the resonance frequency of out-of-plane vibration will change with the methods of support also several%. Here, although out-of-plane vibration is excited by alternation Coriolis force with the frequency of in-plane vibration, it depends for the effectiveness of excitation on the resonance frequency of out-of-plane vibration. If the resonance frequency of the in-plane vibration of a tuning fork and the resonance frequency of out-of-plane vibration are separated, sufficient excitation for out-of-plane vibration cannot be caused, the effectiveness of excitation changes sharply in the resonance frequency of out-of-plane vibration changing sharply by change of delicate support, and accurate detection is impossible. For such a reason, the oscillating gyroscope of a tuning fork mold has come to spread enough.

[0009] The purpose of [purpose of invention] this invention tends to solve the above-mentioned technical problem, and its detection sensitivity is large and is to offer an oscillating gyroscope with a sufficient detection precision.
[0010]
[Means for Solving the Problem] In order to solve the above-mentioned purpose, the oscillating gyroscope of this invention adopts the configuration of a publication as below.

[0011] The oscillating gyroscope of this invention is equipped with four guide pegs, an electrode, and a base, and a guide peg consists of Xtal with elasticity and piezoelectric. The configuration of a guide peg is the square pole. A guide peg a longitudinal direction, a cross direction, and the thickness direction They are Y'Z which rotated in shaft and Y-Z side' shaft which rotated in the Y-Z side of the Xtal crystallographic axis, respectively, and the X-axis. A guide peg has the electrode which consists of metal vacuum evaporationo film given to the side face of the square pole, and a base consists of Xtal with elasticity. The configuration of a base is the square pole, a base and four guide pegs are integral construction, and four guide pegs of each other are arranged in parallel in the base at the typeface of a rice field. The 1st crookedness vibration which vibration of the 1st guide peg produced with the alternating voltage impressed to the electrode of the 1st guide peg transmitted through the base, and produced on all foot The electrical potential difference produced as a result of crookedness vibration of the 2nd of the direction which intersects perpendicularly with the 1st crookedness vibration caused by the Coriolis force by rotation In the electrode which is the oscillating gyroscope detected with the electrode of the 2nd guide peg, and drives a guide peg in the one direction It is characterized by including the electrode formed into the electrode which detects vibration of the one direction of a guide peg succeeding two fields where rectangular Xtal adjoins each other including the electrode formed succeeding two fields where rectangular Xtal adjoins each other.

[0012] The oscillating gyroscope of this invention is equipped with four guide pegs, an electrode, and a base, and a guide peg consists of Xtal with elasticity and piezoelectric. The configuration of a guide peg is the square pole. A guide peg a longitudinal direction, a cross direction, and the thickness direction They are Y'Z which rotated in shaft and Y-Z side' shaft which rotated in the Y-Z side of the Xtal crystallographic axis, respectively, and the X-axis. A guide peg has the electrode which consists of metal vacuum evaporationo film given to the side face of the square pole, and a base consists of Xtal with elasticity. The configuration of a base is the square pole, a base and four guide pegs are integral construction, and four guide pegs of each other are arranged in parallel in the base at the typeface of a rice field. The 1st crookedness vibration which vibration of the 1st guide peg produced with the alternating voltage impressed to the electrode of the 1st guide peg transmitted through the base, and produced on all foot The electrical potential difference produced as a result of crookedness vibration of the 2nd of the direction which intersects perpendicularly with the 1st crookedness vibration caused by the Coriolis force by rotation It is the oscillating gyroscope detected with the electrode of the 2nd guide peg, and is characterized by having formed in two or more guide pegs the electrode which drives a guide peg in the one direction, and forming in two or more guide pegs the electrode which detects vibration of the one direction of a guide peg.

[0013] by having arrange four guide pegs with symmetric property sufficient to the character type of a rice field, also in the vibration [which] use without use the vibration influence by supporter like the out-of-plane vibration in a tuning fork mold, the base be stand it still mostly, by the maintenance approach, the oscillating gyroscope by [operation] this invention do not have effect in an engine performance, and accurate include angle detection can do it. Moreover, excitation for taking a large output signal and coincidence of the resonance frequency of detection can be realized without carrying out excessive expectation to processing assembly precision, the large output signal of the resonance-on structure detection direction can be taken, and since the configuration which can cancel outputs other than Coriolis force is taken, a noise can realize few high S/Ns.

[0014]

[Embodiment of the Invention] Hereafter, the gestalt of operation by the best gestalt for carrying out the oscillating gyroscope of this invention is explained based on a drawing. Drawing 14 to drawing 12 and drawing 16 are oscillating gyroscopes which are the gestalten of operation of this invention from drawing 1 . Drawing 1 It is the perspective view which is called a henceforth 4** type and in which showing the appearance of the oscillating gyroscope of a 4-piece tuning fork mold, and showing cutting bearing started from Xtal rough. Drawing 2 and drawing 3 are the side elevations in which showing the location of an electrode and showing the location of ** for oscillating adjustment. Drawing 4 and drawing 5 are the cross sections and wiring mimetic diagrams of electrode structure of Y' shaft orientations which were seen from the tip side of a 4 ** type guide peg. Drawing 6 is the external view showing the configuration of the oscillating gyroscope which enclosed 4** type with cylinder-like tubing. Drawing 7 R> 7, drawing 8 , drawing 9 , and drawing 10 are the explanatory views of operation which expressed typically the cross section of Y' shaft orientations seen from the tip side of a 4 ** type guide peg. Drawing 11 and drawing 12 are the plans showing the appearance of wiring of 4 ** type 10. Drawing 14 is the cross section and wiring mimetic diagram of electrode structure of Y' shaft orientations which were seen from the tip side of the guide peg of 4 ** type 10 which shows the gestalt of another operation. Drawing 15 and drawing 16 are the cross sections and wiring mimetic diagrams of electrode structure of Y' shaft orientations which were seen from the tip side of the guide peg of 4 ** type 10 which is the perspective view showing the gestalt of another operation, and shows the gestalt of operation with another drawing 17 , and drawing 18 is the perspective view showing the gestalt of another operation.

[0015] Structure explanation of [oscillating gyroscope: As shown in drawing 6 R> 6, drawing 11 , and drawing 12] drawing 1 from drawing 1 , 4 ** type 10 consists of the 1st guide peg 11, the 2nd guide peg 12, the 3rd guide peg 13 and the 4th guide peg 14, an electrode that is not illustrated, and a base 15. It has the electrode which a guide peg consists of Xtal with elasticity and piezoelectric, and consists of metal vacuum evaporationo film which a configuration is the square pole and was given to the side face of the square pole. A base consists of Xtal with elasticity and a configuration is the square pole. The 1st guide peg 11, 2nd guide peg 12, 3rd guide peg 13, and 4th guide peg 14 of each other are arranged in parallel in the location of four top-most vertices of the rectangular base 15, and a base 15, the 1st guide peg 11, the 2nd guide peg 12 and the 3rd guide peg 13, and the 4th guide peg 14 are integral construction.

[0016] Xtal which is used with the gestalt of this operation and which is generally used for vibrator belongs to trigonal system with four crystallographics axis in ordinary temperature with the single crystal of Si02. It is the crystallographic axis which one of the crystallographics axis is called a c-axis, it is a crystallographic axis passing through the top-most vertices of a crystal, and the three remaining are called an a-axis, and accomplishes the include angle of 120 degrees mutually in a field perpendicular to a c-axis. Here, the X-axis is set as either of three a-axes, the Z-axis is set as a c-axis, and a Y-axis is taken in the direction which intersects perpendicularly with the X-axis and the Z-axis.

[0017] 4 ** type 10 carries out each side at parallel, and it is started by an X, Y, and axis-of-coordinates [which was rotated around the 0 - 10 degree X-axis from the Z-axis] Y'shaft and Z' shaft, and the X-axis. Y' shaft is set as the direction where the longitudinal direction, i.e., a guide peg, was extended at this time, and the X-axis is set as Z' shaft and the thickness direction for a cross direction. In this way, the longitudinal direction, cross direction, and the thickness direction of 4 ** type 10 started become respectively parallel to Y'shaft and Z' shaft and the X-axis. However, since 4 ** type 10 has a symmetrical configuration in a X-Z' side, the word "thickness" which were used here does not have special semantics. [the width and thickness] Below, the word "width" of X or the direction of Z' is used.

[0018] Signs that the electrode which changes from the metal vacuum evaporationo film to the 1st guide peg 11 and the 2nd guide peg 12 as an example was formed in drawing 2 and drawing 3 are shown. Fig. 2 and drawing 3 are perspective views, and since drawing becomes complicated, the electrode of the 3rd guide peg and the 4th guide peg is not illustrated here. The configuration of an electrode creates the mask which created the configuration by etching beforehand, and forms it by sticking this on the field of Xtal which generates an electrode, and giving vacuum deposition. The 1st electrode 23 and 24 was vapor-deposited on 1st foot 11 as an object for excitation, and the 2nd electrode 25 and 26 with which polarities differ is vapor-deposited. The 1st electrode 23 and 24 of each other is connected here using the side face of the 1st guide peg. Moreover, the 2nd electrode 25 and 26 of each other is also connected using the side face of the 1st guide peg. Furthermore, as an object for excitation, the 3rd electrode 27 and 28 was vapor-deposited on 2nd foot 12, and the 4th electrode 29 and 30 with which polarities differ is vapor-deposited. Here, the 3rd electrode 27 and 28 of each other is connected using the side face of the 2nd guide peg. Moreover, the 4th electrode 29 and 30 of each other is also connected using the side face of the 2nd guide peg. Since it was a perspective view in drawing 2 , since electrodes 24, 25, 28, and 30 were not illustratable, they gave the sign to the path which bypasses a side face and is connected mutually.

[0019] The same electrodes 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, and 38 as what shows a part to drawing 4 and drawing 5 at drawing 2 are shown in the cross section within the X-Z' side which cuts the 1st guide peg 11, the 2nd guide peg 12, the 3rd guide peg 13, and the 4th guide peg 14. The 1st electrode 23 and 24 was vapor-deposited on 1st foot 11 as an object for excitation, the 2nd electrode 25 and 26 with which polarities differ was vapor-deposited, and the 4th electrode 29 and 30 with which the polarities which vapor-deposited the 3rd electrode 27 and 28 formed succeeding two fields which adjoin the 2nd guide peg 12, and formed it succeeding two adjacent fields differ is vapor-deposited. Moreover, the 8th electrode 37 and 38 with which the polarities which vapor-deposited the 5th electrode 31 and 32 on 3rd foot 13, vapor-deposited on it the 7th electrode 35 and 36 formed succeeding two fields which vapor-deposit the 6th electrode 33 and 34 with which polarities differ, and adjoin each other at the 4th guide peg 14, and were formed in it as an object for detection succeeding two adjacent fields differ is vapor-deposited.

[0020] The oscillator circuit 43 which impresses alternating voltage to the electrodes 23, 24, 25, 26, 27, 28, 29, and 30 for excitation, and the 2nd detector 46 which detects the signal from the 1st detector 45, 35, 36, 37, and 38 which detects the signal from the electrodes 31, 32, 33, and 34 for detection are shown in drawing 4 , and wiring between these is shown. moreover, in drawing 5 To the electrodes 23, 24, 25, and 26 for excitation, alternating voltage The 2nd oscillator circuit 49 which impresses alternating voltage to the 1st oscillator circuit 48 to impress and the electrodes 27, 28, 29, and 30 for excitation, and the 2nd detector 46 which detects the signal from the 1st detector 45, 35, 36, 37, and 38 which detects the signal from the electrodes 31, 32, 33, and 34 for detection are shown. Wiring between

these is shown.
[0021] The configuration as a gyroscope component which enclosed 4 ** type 10 with cylinder-like tubing at drawing 6 is shown. Although the base 16 consists of insulating ingredients, such as a ceramic, the wiring substrate 22 is pasted up on the top face. 4 ** type 10 carries out adhesion immobilization of the base 15 with the wiring substrate 22. The base 16 which fixed 4 ** type 10 keeps constant the internal environment in which 4 ** type 10 exists by pressing fit in the metal cap 17 and closing with the base 16 and the metal cap 17. This internal environment is made into the ambient atmosphere of inert gas, such as nitrogen, considers that the oscillation characteristic, i.e., Q value and CI value, of 4 ** type 10 as a trembler become what it is easy to treat as an oscillating gyroscope, and adjusts an atmospheric pressure.
[0022] It is necessary to connect electrically the terminal area of the electrodes 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, and 38 shown in drawing 2 or drawing 4 , and drawing 5 which were vapor-deposited by 4 ** type 10 with the leads 18, 19, 20, and 21 which carry out airtight press fit at the base 16. The wiring 63, 64, 65, 66, 67, 68, 69, and 70 formed on the wiring substrate is shown in drawing 11 and drawing 12 . Drawing 11 shows wiring corresponding to drawing 2 , and although drawing 12 shows wiring corresponding to drawing 3 , it can wire freely using the side face and substrate of a guide peg. Although the terminal area of electrodes 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, and 38 is an extension of the electrode formed to the base of the base 15 of 4 ** type 10 beforehand, these terminal area and wiring 63, 64, 65, 66, 67, 68, 69, and 70 are constituted so that a location may be in agreement -- having -- **** -- each -- the same polar things are easily joined by the pewter or electric conduction adhesives. moreover, some wiring 63, 64, 65, 66, 67, 68, 69, and 70 is formed so that leads 18, 19, 20, and 21 may be surrounded -- having -- **** -- wiring and a lead -- each -- the same polar things are easily joined by solder or electric conduction adhesives. Leads 18, 19, 20, and 21 are connected to the 1st oscillator circuit 48, the 2nd oscillator circuit 49 and the 1st detector 45, and 2nd detector 46 which showed drawing 5 whether it would connect with the oscillator circuit 43 and the 1st detector 45 which were shown in drawing 4 , and the 2nd detector 46.
[0023] Actuation / operation explanation of [oscillating gyroscope : from drawing 4 , drawing 5 , drawing 10 from drawing 7 , and drawing 14 In drawing 18] drawing 4 , a point shows the 1st neutral line 39 of crookedness vibration of the direction of Y' of the 1st guide peg 11. A point shows the 2nd neutral line 40 of crookedness vibration of the 2nd guide peg 12 of the direction of Y', a point shows the 3rd neutral line 41 of crookedness vibration of the 3rd guide peg 13 of the direction of Y', and a point shows the 4th neutral line 42 of crookedness vibration of the 4th guide peg 14 of the direction of Y'. The line of the outside of drawing is what showed each inter-electrode wiring typically, and is connected to an oscillator circuit 43, the 1st detector 45, and the 2nd detector 46. Although an arrow head shows the situation of a certain instantaneous electrical potential difference among drawing, an arrow head shows the 1st electrical potential difference 51, an arrow head shows the 2nd electrical potential difference 52, an arrow head shows the 3rd electrical potential difference 53, and the arrow head shows the 4th electrical potential difference 54.
[0024] first -- supposing the 1st electrical potential difference 51 and 2nd electrical potential difference 52 are impressed with the alternating voltage from an oscillator circuit 43 through the 1st electrodes 23 and 24 and 2nd electrode 25 and 26 of a guide peg 11 and the direction of the direction of elongation and the 2nd electrical potential difference 52 of the 1st electrical potential difference 51 shrinks -- Z' shaft orientations -- crookedness -- a variation rate happens. [1st] With the passage of time, this direction changes and the 1st guide peg 11 carries out crookedness vibration as a result at Z' shaft orientations. If the frequency of an oscillator circuit 43 is near the resonance frequency as an elastic body of 4 ** type 10 even if the guide peg to drive is only the 1st guide peg 11 at this time Vibration of the 1st guide peg 11 transmits through a base 15, and the 2nd guide peg 12, the 3rd guide peg 13, and the 4th guide peg 14 are excited automatically. The 1st guide peg 11 and 3rd guide peg 13 It sways in a tuning fork mold in Y'-Z' side, The 1st crookedness vibration to which the 2nd guide peg 12 and 4th guide peg 14 sway in a tuning fork mold in a Y-Z' side by vibration and opposition of the 1st guide peg 11 and the 3rd guide peg 13 occurs.

[0025] supposing the 3rd electrical potential difference 53 and 4th electrical potential difference 54 are impressed with this, simultaneously the alternating voltage from an oscillator circuit 43 through the 2nd electrodes 27 and 28 and 4th electrode 29 and 30 of a guide peg 12 and the direction of the direction of elongation and the 4th electrical potential difference 54 of the 3rd electrical potential difference 53 shrinks -- X shaft orientations -- crookedness -- a variation rate happens. [3rd] With the passage of time, this direction changes and the 2nd guide peg 12 carries out crookedness vibration as a result at X shaft orientations. If the frequency of an oscillator circuit 43 is near the resonance frequency as an elastic body of 4 ** type 10 even if the guide peg driven at this time is only the 2nd guide peg 12 Vibration of the 2nd guide peg 12 transmits through a base 15, and the 1st guide peg 11, the 3rd guide peg 13, and the 4th guide peg 14 are excited automatically. The 2nd guide peg 12 and 1st guide peg 11 The 2nd crookedness vibration to which it sways in a tuning fork mold in a Y'-X side, and the 4th guide peg 14 and 3rd guide peg 13 sway in a tuning fork mold in a Y-X side by vibration and opposition of the 2nd guide peg 12 and the 1st guide peg 11 occurs.
[0026] The 1st crookedness vibration is typically shown in drawing 7 . Although a guide peg 11, the 2nd guide peg 12, and the 1st guide peg 13 and 4th guide peg 14 of 4 ** type 10 perform crookedness vibration in Y'-Z' side in the 1st crookedness vibration, the arrow head shows the instantaneous displacement direction which it is here. [3rd] Moreover, the 2nd crookedness vibration is typically shown in drawing 8 . In the 2nd crookedness vibration, the 1st guide peg 11, 2nd guide peg 12, 3rd guide peg 13, and 4th guide peg 14 of 4 ** type 10 perform crookedness vibration in a Y'-X side. The continuous-line arrow head shows the instantaneous displacement direction which it is also here.
[0027] As for the 2nd crookedness vibration shown in the 1st crookedness vibration and drawing 8 which were shown in drawing 7 , existence of the resonance frequency as an elastic body is ******(ed) by the check of the prototype of 4 ** type 10 of operation. That is, in the 1st crookedness vibration, all guide pegs are vibrating in the direction of Z', the 1st guide peg 11 and 3rd guide peg 13 are performing the usual tuning fork mold vibration, and the 2nd guide peg 12 and 4th guide peg 14 are performing tuning fork mold vibration of the opposition of vibration which the 1st guide peg 11 and 3rd guide peg 13 perform to coincidence at this time. On the other hand, in the 2nd crookedness vibration, all guide pegs are vibrating in the direction of X, the 1st guide peg 11 and 2nd guide peg 12 are performing the usual tuning fork mold vibration, and the 3rd guide peg 13 and 4th guide peg 14 are performing tuning fork mold vibration of the opposition of vibration which the 1st guide peg 11 and 2nd guide peg 12 perform to coincidence at this time. Since, as for these vibration, four guide pegs scramble for balance mutually, the base 15 serves as a knot of vibration and it hardly vibrates, 4 ** type 10 does not almost have that a vibrational state changes by the approach of support.
[0028] The 1st crookedness vibration shown in drawing 7 now, for example, beforehand, is made to perform, and the 2nd crookedness vibration shown in coincidence at drawing 8 is generated. Generally however, the resonance frequency of the 1st crookedness vibration and the 2nd crookedness vibration In 4 ** type 10 which consists of the X-axis and Xtal cut down by Y'shaft and Z' shaft orientations The resonance frequency as an elastic body of the 1st crookedness vibration and the 2nd crookedness vibration is not in agreement when the 1st guide peg 11, the 2nd guide peg 12, the 3rd guide peg 13, the 4th guide peg 14, and a cross-section configuration perpendicular to the direction of Y' of a base 15 are symmetrical in X and the direction of Z'.
[0029] The work which brings the resonance frequency of the 1st crookedness vibration and the resonance frequency of the 2nd crookedness vibration close here is carried out. Since the frequency of crookedness vibration of a cylindrical oscillating object is proportional to the width of the crookedness direction, it transforms a cross section perpendicular to Y' shaft of 4 ** type 10 here so that it may become the rectangular section which reduced the direction of Z' about 1% to the direction of X instead of a square. The resonance frequency of the 2nd crookedness vibration is mostly in agreement with the resonance frequency of the 1st crookedness vibration with this deformation.
[0030] However, when mass production is taken into consideration, the process tolerance by the wire saw generally used for processing of Xtal is about 6 micrometers by width, but if width of the guide peg of ** of 4 ** type 10 is set to about 300 micrometers, for example, 1% will become the limitation of

process tolerance. Since the resonance frequency of a cylindrical oscillating object is inversely proportional to the square of the die length of a rod when you need adjustment beyond this, it is processed so that the depth of ** of ** may differ, as the die length L1 of the guide peg seen from Z' as shown in drawing 2 differs from the die length L2 of the guide peg seen from X. The resonance frequency of the 1st crookedness vibration and the resonance frequency of the 2nd crookedness vibration can be made in agreement with a more sufficient precision by processing only this part local still with high precision.

[0031] The situation of crookedness vibration of 4 ** type 10 in case the 1st crookedness vibration and the 2nd crookedness vibration exist in drawing 9 at coincidence is shown typically. Coincidence is made to generate the 1st crookedness vibration and the 2nd crookedness vibration as an oscillator circuit in the circuitry of drawing 4 in one oscillator circuit 43. in this case, the mechanical vibration system of 4 ** type 10 which performs 1st crookedness vibration and the mechanical vibration system of 4 ** type 10 which performs 2nd crookedness vibration -- an oscillator circuit 43 -- joining together -- the oscillation frequency f1 of the 1st crookedness vibration, a phase delta 1 and the oscillation frequency f2 of the 2nd crookedness vibration, and a phase delta 2 -- each -- the 3rd crookedness vibration shown in drawing 9 in the same ** occurs.

[0032] However, since piezoelectric [of Xtal] is based only on the electric field of the direction of X, the electric field which generally cause crookedness of the direction of Z' become weak compared with the electric field which cause crookedness of the direction of X. In this operation gestalt, since the 3rd electrode 27 and 28 formed succeeding the field with the sufficient generating effectiveness of the electric field which cause crookedness of the direction of Z' which is adjacent two, the 4th electrode 29 and 30, the 7th electrode 35 and 36, and the 8th electrode 37 and 38 were used, the 2nd crookedness vibration can obtain the almost equivalent amplitude to the 1st crookedness vibration.

[0033] In the circuitry of drawing 5 , the 1st crookedness vibration is generated in the 1st oscillator circuit 48. Generate the 2nd crookedness vibration in the 2nd oscillator circuit 49, and phase contrast with the oscillation frequency of the 1st oscillator circuit 48 is detected by making the oscillation of the 2nd oscillator circuit 49 into a reference sign. the oscillation frequency f1 of the 1st crookedness vibration by the PLL circuit 50 which transposes this to an electrical potential difference and is fed back to the varicap of the 1st oscillator circuit 48, a phase delta 1 and the oscillation frequency f2 of the 2nd crookedness vibration, and a phase delta 2 -- each -- the same -- it is **(ing). The 3rd crookedness vibration which shows the oscillator circuit shown in drawing 4 as a result to drawing 9 as well as the circuitry used only one occurs. In this case, the amplitude of the 1st crookedness vibration and the 2nd crookedness vibration can be adjusted beforehand, and the direction of the 3rd crookedness vibration can be adjusted.

[0034] By the way, if 4 ** type 10 rotates with angular velocity omega around Y' shaft when the 3rd crookedness vibration shown in drawing 9 has occurred, the guide peg of ** will receive Coriolis force in the direction which intersects perpendicularly in the direction to displace, and the 4th crookedness vibration shown in drawing 10 by this Coriolis force will be caused. The 3rd crookedness vibration and oscillation frequency of crookedness vibration [4th] correspond completely. Therefore, according to the theory of forced oscillation, excitation of the 4th crookedness vibration by the 3rd crookedness vibration is performed at the highest effectiveness, and can obtain the amplitude with the 4th very big crookedness vibration.

[0035] The 4th crookedness vibration has the 5th crookedness vibration in the direction of Z' as a component, and has the 6th crookedness vibration in the direction of X which intersects perpendicularly with the 5th crookedness vibration as a component. For example, in the 6th crookedness vibration, for example in the 4th guide peg 14, the distortion within a Y'-X side is produced and the 7th electrical potential difference 57 and 8th electrical potential difference 58 are generated by piezo-electric basic type ey=d12*EX of Xtal. ey is [a piezoelectric constant and EX of the direction distortion of Y' and d12] the electrical potential differences of the direction of X here. Here, since other piezoelectric constants are small, they have been omitted. Although the direction distortion ey of Y' is proportional to angular velocity omega according to the principle of Coriolis force generating, according to the upper type, it will be proportional to the 7th electrical potential difference 57 and 8th electrical potential difference 58 further. Therefore, the 7th electrical potential difference 57 and 8th electrical potential difference 58 are drawn as an electrical potential difference proportional to angular velocity omega with the electrodes 35, 36, 37, and 38 of the 4th guide peg 14 which **5**(ed), and are inputted into a detector 45. Similarly, by the 5th crookedness vibration, for example in the 3rd guide peg 13, it is led as an electrical potential difference proportional to angular velocity omega in Y'-Z' side with the electrodes 31, 32, 33, and 34 of the 3rd guide peg 13 which **5**(ed), and is inputted into a detector 46.

[0036] However, the electrical potential difference which already originates in crookedness vibration the 1st, and the electrical potential difference resulting from the 2nd crookedness vibration are already inputted into the detector 45 and the detector 46. The output of a detector 45 and a detector 46 is inputted into the differential amplifier 47, and the differential amplifier 47 is adjusted so that the output which originates in the 1st crookedness vibration and the 2nd crookedness vibration beforehand may cancel and an output may be set to 0. Since the 6th crookedness vibration which commits the 5th crookedness vibration which works in the direction of Z' so that the 1st crookedness vibration which similarly works in the direction of Z' may be weakened, and works in the direction of X commits so that the 2nd crookedness vibration which similarly works in the direction of X may be strengthened, differential-amplifier 50 output generates by the crookedness vibration of the 5th and the crookedness vibration of the 6th which generated by Coriolis force and which is the component of the 4th crookedness vibration. The value of angular velocity omega can be known by this. Here, also when acceleration other than rotation joins 4 ** type 10, an output appears in a detector 45 and a detector 46, but since these are canceled, only the output corresponding to rotation is outputted from the differential amplifier 50.

[0037] Although the input of a detector 45 and a detector 46 will become quite big, in order to raise detection precision by the above invention, the big amplifier of a S/N ratio is required. There are some which are generally called lock in amplifier as big amplifier of a S/N ratio. Lock in amplifier is the thing of the thought which filters a detecting signal by the reference sign.

[0038] It combines with an oscillator circuit 43 or the 1st oscillator circuit 48, and the 2nd oscillator circuit 49, and the 1st crookedness vibration of 4 ** type 10 in this invention constitutes the crystal oscillator with very big Q value. That is, it is a signal with the frequency stabilized very much. In other words, most noises other than the signal resulting from angular velocity omega are excludable by using this. The detectors 45 and 46 of drawing 4 and drawing 5 consist of pre amplifier and lock in amplifier, and the signal of an oscillator circuit 43 or the 1st oscillator circuit 48 is used for them as a reference sign. Therefore, the lock in amplifier which makes the signal from the 1st crookedness vibration a reference sign can realize magnification with a big S/N ratio on the occasion of detection of the signal from the 5th crookedness vibration and the 6th crookedness vibration.

[0039] By the way, in a configuration with two oscillator circuits shown in drawing 5, since the amplitude of the 1st crookedness vibration and the 2nd crookedness vibration can be adjusted beforehand, priority is given to the ease of manufacturing, and even if it changes into the configuration which is easy to form an electrode, it does not interfere. Since a process becomes complicated, I want to simplify the mask between ** if possible, although formed by the electrode's creating the mask which created the configuration by etching beforehand, sticking this on the field of Xtal which generates an electrode in the gestalt of this operation, and giving vacuum deposition.

[0040] What was shown in drawing 16 by drawing 4 and drawing 5 from drawing 14 shows another electrode. supposing an electrical potential difference 103 and an electrical potential difference 104 are impressed through the 2nd electrode 83 and electrode 84 of a guide peg 12 with the alternating voltage from the 1st oscillator circuit 48 and the direction of the direction of elongation and an electrical potential difference 104 of an electrical potential difference 103 shrinks in drawing 14 -- X shaft orientations -- crookedness -- a variation rate happens. With the passage of time, this direction changes and the 2nd guide peg 12 carries out crookedness vibration as a result at X shaft orientations. If the frequency of the 1st oscillator circuit 48 is near the resonance frequency as an elastic body of 4 ** type 10 even if the guide peg to drive is only the 2nd guide peg 12 at this time Vibration of the 2nd guide peg

12 transmits through a base 15, the 1st guide peg 11, the 3rd guide peg 13, and the 4th guide peg 14 are excited automatically, and the 1st guide peg 11 and 2nd guide peg 12 sway in a tuning fork mold in a Y'-X side. The 3rd guide peg 13 and 4th guide peg 14 in a Y-X side Vibration of the 1st guide peg 11 and the 2nd guide peg 12 and the 1st crookedness vibration which sways in a tuning fork mold by opposition occur.

[0041] supposing an electrical potential difference 107 and an electrical potential difference 108 are impressed through the 4th electrodes 89 and 90 and electrodes 91 and 92 of a guide peg 14 with this, simultaneously the alternating voltage from the 2nd oscillator circuit 49 and the direction of the direction of elongation and an electrical potential difference 108 of an electrical potential difference 107 shrinks -- Z' shaft orientations -- crookedness -- a variation rate happens. This direction changes with the passage of time, and, as a result, the 4th guide peg 14 carries out crookedness vibration at Z' shaft orientations. If the frequency of the 2nd oscillator circuit 49 is near resonance frequency as an elastic body of 4 ** type 10 even if the guide peg driven at this time is only the 4th guide peg 14 Vibration of the 4th guide peg 14 transmits through a base 15, and the 1st guide peg 11, the 2nd guide peg 12, and the 3rd guide peg 13 are excited automatically. the 3rd guide peg 13 and 1st guide peg 11 -- the inside of Y'-Z' side -- a tuning fork mold -- swaying -- the 4th guide peg 14 and 2nd guide peg 12 -- Y-Z' -- vibration of the 3rd guide peg 13 and the 1st guide peg 11 and the 2nd crookedness vibration which sways in a tuning fork mold by opposition occur in a field.

[0042] The electrode shown in drawing 14 also generates electric field efficiently including the electrode formed succeeding two adjacent fields as well as the electrode shown in drawing 4 and drawing 5 . In the electrode furthermore shown in drawing 14 R> 4, there are few mask processes between ** and they can manufacture 4 ** type 10 to low cost more.

[0043] Apart from the approach using the efficient electrode made to generate electric field as shown in drawing 4 , drawing 5 , and drawing 14 , there is also an approach using a simple electrode two or more. The electrode which makes drawing 17 and drawing 18 excite two or more guide pegs to coincidence is shown. supposing an electrical potential difference 131 and an electrical potential difference 132 are impressed with the alternating voltage from the 1st oscillator circuit 48 through the 2nd electrode 116, electrode 117, and electrode 118 of a guide peg 12 and the direction of the direction of elongation and an electrical potential difference 132 of an electrical potential difference 131 shrinks in drawing 17 -- X shaft orientations -- crookedness -- a variation rate happens. This direction changes with the passage of time, and the 2nd guide peg 12 carries out crookedness vibration as a result at X shaft orientations. supposing an electrical potential difference 134 and an electrical potential difference 135 are impressed to coincidence through the 3rd electrode 121, electrode 122, and electrode 123 of a guide peg 13 at this time, the direction of an electrical potential difference 135 is extended and the direction of an electrical potential difference 134 is shrunken -- X shaft orientations -- crookedness -- a variation rate happens. This direction changes with the passage of time, and the 3rd guide peg 13 carries out crookedness vibration as a result at X shaft orientations. Even if the guide peg to drive is only the 2nd guide peg 12 and 3rd guide peg 13 at this time If the frequency of the 1st oscillator circuit 48 is near the resonance frequency as an elastic body of 4 ** type 10 Vibration of the 2nd guide peg 12 and the 3rd guide peg 13 transmits through a base 15. The 1st guide peg 11 and 4th guide peg 14 are excited automatically, and the 1st guide peg 11 and 2nd guide peg 12 are. It sways in a tuning fork mold in a Y'-X side, The 1st crookedness vibration to which the 3rd guide peg 13 and 4th guide peg 14 sway in a tuning fork mold in a Y-X side by vibration and opposition of the 1st guide peg 11 and the 2nd guide peg 12 occurs.

[0044] supposing an electrical potential difference 131 and an electrical potential difference 133 are impressed through the 2nd electrode 119 and electrode 120 of a guide peg 12 with this, simultaneously the alternating voltage from the 2nd oscillator circuit 49 and the direction of the direction of elongation and an electrical potential difference 133 of an electrical potential difference 131 shrinks in drawing 17 -- Z' shaft orientations -- crookedness -- a variation rate happens. With the passage of time, this direction changes and the 2nd guide peg 12 carries out crookedness vibration as a result at Z' shaft orientations. supposing an electrical potential difference 134 and an electrical potential difference 136 are impressed through the 3rd electrode 124 and electrode 125 of a guide peg 13 with this, simultaneously the

alternating voltage from the 2nd oscillator circuit 49 and the direction of the direction of elongation and an electrical potential difference 136 of an electrical potential difference 134 shrinks -- Z' shaft orientations -- crookedness -- a variation rate happens. This direction changes with the passage of time, and the 3rd guide peg 13 carries out crookedness vibration as a result at Z' shaft orientations. Even if the guide peg driven at this time is only the 2nd guide peg 12 and 3rd guide peg 13 If the frequency of the 2nd oscillator circuit 49 is near the resonance frequency as an elastic body of 4 ** type 10 Vibration of the 2nd guide peg 12 and the 3rd guide peg 13 transmits through a base 15. The 1st guide peg 11 and 4th guide peg 14 are excited automatically, and the 3rd guide peg 13 and 1st guide peg 11 sway in a tuning fork mold in Y'-Z' side, The 2nd crookedness vibration to which the 4th guide peg 14 and 2nd guide peg 12 sway in a tuning fork mold in a Y-Z' side by vibration and opposition of the 3rd guide peg 13 and the 1st guide peg 11 occurs.
[0045] The electrical potential difference which the detection electrodes 111,112 and 113 formed in the 1st guide peg 11 which detects the 5th [which is generated by Coriolis force in the circuit shown in drawing 17 from the 3rd crookedness vibration which is a synthetic vibration of the 1st crookedness vibration and the 2nd crookedness vibration] crookedness vibration which is the component of the direction of X of the 4th crookedness vibration generate The electrical potential difference which the detection electrodes 114 and 115 formed in the 1st guide peg 11 which is inputted into the 1st detector 45 and detects the 6th crookedness vibration which is the component of the direction of Z' of the 4th crookedness vibration generate is inputted into the 2nd detector 46. The differential amplifier of the output of the 1st detector 45 and the output of the 2nd detector 47 is carried out with the differential amplifier 47. The electrical potential difference which the detection electrodes 126,127 and 128 formed in the 4th guide peg 14 which furthermore detects the 5th crookedness vibration generate The electrical potential difference which the detection electrodes 129 and 130 formed in the 4th guide peg 14 which is inputted into the 3rd detector 97 and detects the 6th crookedness vibration generate is inputted into the 4th detector 98, and the differential amplifier of the output of the 3rd detector 97 and the output of the 4th detector 98 is carried out with the differential amplifier 99. And as a result by which the output of the differential amplifier 47 and the differential amplifier 99 is compounded with the differential amplifier 100, the output of the differential amplifier 100 becomes very few things of the effect of noises other than Coriolis force.
[0046] In the electrode shown in drawing 17 , not an electrode with the sufficient electric-field generating effectiveness shown in drawing 4 , drawing 5 , and drawing 14 but the usual electrode is formed in two or more guide pegs, and it excites efficiently. The electrode shown in drawing 1717 does not have a mask process between **, and can manufacture 4 ** type 10 to low cost more.
[0047]
[Effect of the Invention] By the above explanation, the oscillating gyroscope by this invention by having arranged four guide pegs with sufficient symmetric property so that clearly Also in vibration [which], the base is standing it still, and there is no effect in the engine performance by the maintenance approach. Since excitation for taking large gain and coincidence of the resonance frequency of detection can be realized without carrying out excessive expectation to processing assembly precision, are fit for mass production. The large gain of the resonance-on structure detection direction could be taken, and since the configuration which can cancel outputs other than Coriolis force is taken, there are few noises and they have realized high S/N.

[Translation done.]

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DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is the perspective view in which showing the appearance of the oscillating gyroscope of the 4-piece tuning fork mold which is the gestalt of operation of this invention, and showing cutting bearing started from Xtal rough.
[Drawing 2] It is the perspective view in which showing the location of the electrode of the Xtal 4 ****** gyroscope which is the gestalt of operation of this invention, and showing the location of ** for oscillating adjustment.
[Drawing 3] It is the perspective view in which showing the location of the electrode of the Xtal 4 ****** gyroscope which is the gestalt of operation of this invention, and showing the location of ** for oscillating adjustment.
[Drawing 4] It is the drawing in which the cross section and ****** type of electrode structure of Y' shaft orientations which were seen from the tip side of the guide peg of the Xtal 4 ****** gyroscope which is the gestalt of operation of this invention are shown.
[Drawing 5] It is the drawing in which the cross section and ****** type of electrode structure of Y' shaft orientations which were seen from the tip side of the guide peg of the Xtal 4 ****** gyroscope which is the gestalt of operation of this invention are shown.
[Drawing 6] It is the drawing of an appearance in which the configuration of the gyroscope component enclosed with tubing of the shape of a cylinder of the Xtal 4 ****** gyroscope which is the gestalt of operation of this invention is shown.
[Drawing 7] It is the drawing of explanation of operation which expressed typically the cross section of Y' shaft orientations seen from the tip side of the guide peg of the Xtal 4 ****** gyroscope which is the gestalt of operation of this invention.
[Drawing 8] It is the drawing of explanation of operation which expressed typically the cross section of Y' shaft orientations seen from the tip side of the guide peg of the Xtal 4 ****** gyroscope which is the gestalt of operation of this invention.
[Drawing 9] It is the drawing of explanation of operation which expressed typically the cross section of Y' shaft orientations seen from the tip side of the guide peg of the Xtal 4 ****** gyroscope which is the gestalt of operation of this invention.
[Drawing 10] It is the drawing of explanation of operation which expressed typically the cross section of Y' shaft orientations seen from the tip side of the guide peg of the Xtal 4 ****** gyroscope which is the gestalt of operation of this invention.
[Drawing 11] It is the drawing from a top face in which the appearance of wiring of the Xtal 4 ****** gyroscope which is the gestalt of operation of this invention is shown.
[Drawing 12] It is the drawing from a top face in which the appearance of wiring of the Xtal 4 ****** gyroscope which is the gestalt of operation of this invention is shown.
[Drawing 13] It is the perspective view showing the conventional tuning fork mold oscillating gyroscope.
[Drawing 14] They are the cross section of the electrode structure of Y' shaft orientations seen from the

tip side of the guide peg of the Xtal 4 ****** gyroscope which is the gestalt of operation of this invention, and the drawing of a ****** type.
[Drawing 15] It is the perspective view showing the location of the electrode of the Xtal 4 ****** gyroscope which is the gestalt of operation of this invention.
[Drawing 16] It is the perspective view showing the location of the electrode of the Xtal 4 ****** gyroscope which is the gestalt of operation of this invention.
[Drawing 17] It is the drawing in which the cross section and ****** type of electrode structure of Y' shaft orientations which were seen from the tip side of the guide peg of the Xtal 4 ****** gyroscope which is the gestalt of operation of this invention are shown.
[Drawing 18] It is the perspective view showing the location of the electrode of the Xtal 4 ****** gyroscope which is the gestalt of operation of this invention.
[Description of Notations]
10 Xtal 4 ****** Gyroscope
11, 12, 13, 14 Guide peg of 4 **
15 Base of 4 **
16 Base
17 Metal Cap
18, 19, 20, 21 Lead wire
22 Wiring Substrate
23-38 Electrode
39-42 The neutral line of crookedness vibration
43 Oscillator Circuit
44 Detector
45 Detector 1
46 Detector 2
47 Differential Amplifying Circuit
48 Oscillator Circuit 1
49 Oscillator Circuit 2
50 PLL Control Loop
51-58 The electrical-potential-difference direction
59-70 Wiring
71 Oscillating Object
72 73 The 1st guide peg of a tuning fork
74 75 The 2nd guide peg of a tuning fork
76 Drive Electrode
77 Detection Electrode
81-92 Electrode
97 Detector 3
98 Detector 4
99 Differential Amplifying Circuit
100 Adder Circuit
101-108 The electrical-potential-difference direction
111-130 Electrode
131-136 The electrical-potential-difference direction

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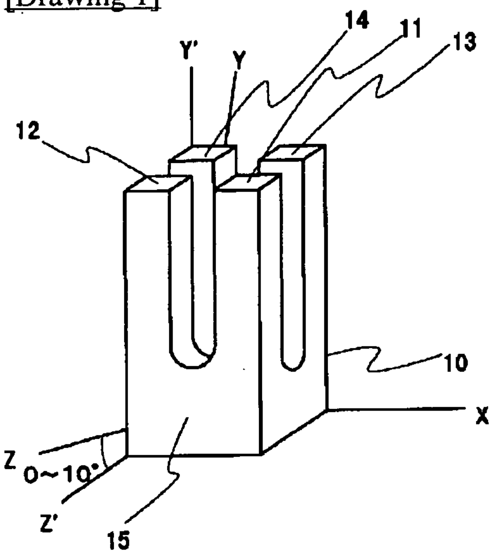
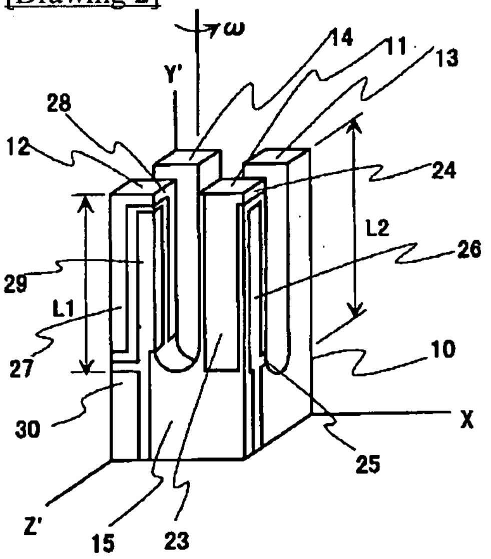
3.In the drawings, any words are not translated.

DRAWINGS

[Drawing 1]



[Drawing 2]



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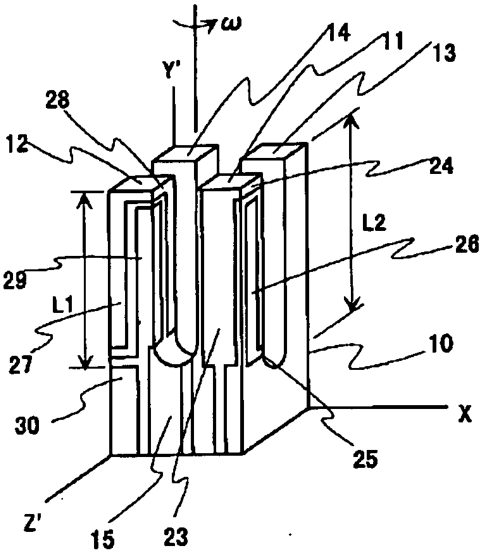

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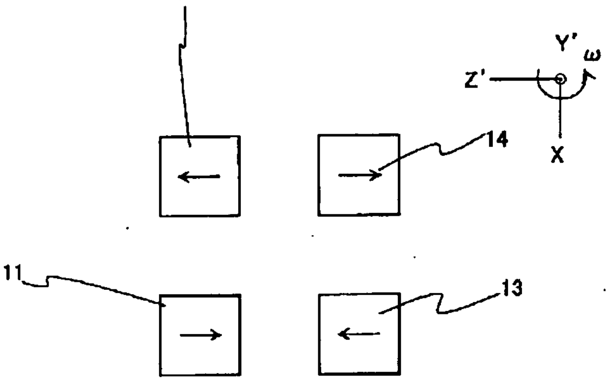

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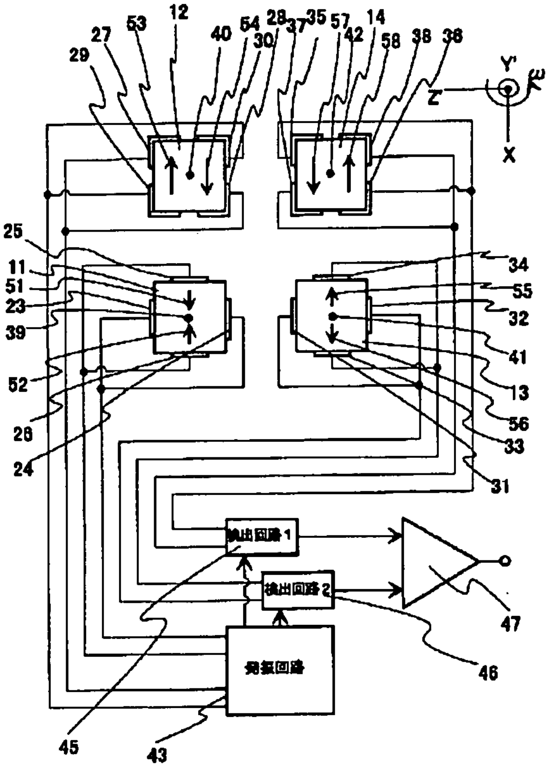
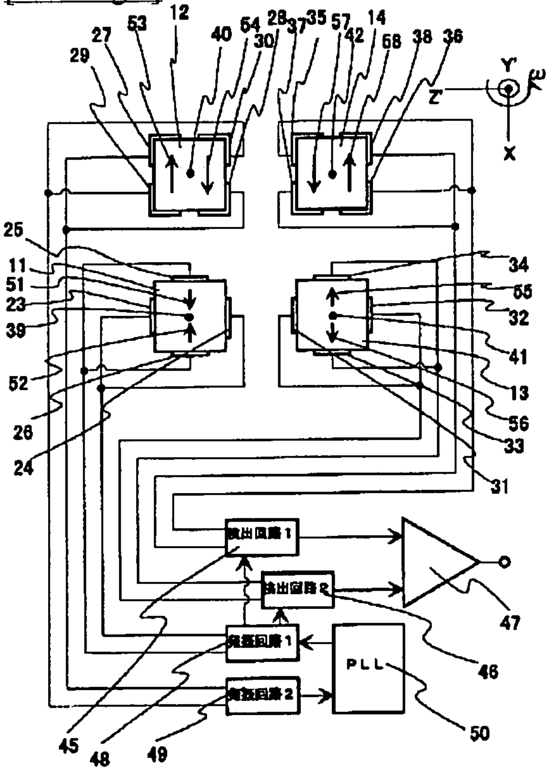


[Drawing 5]



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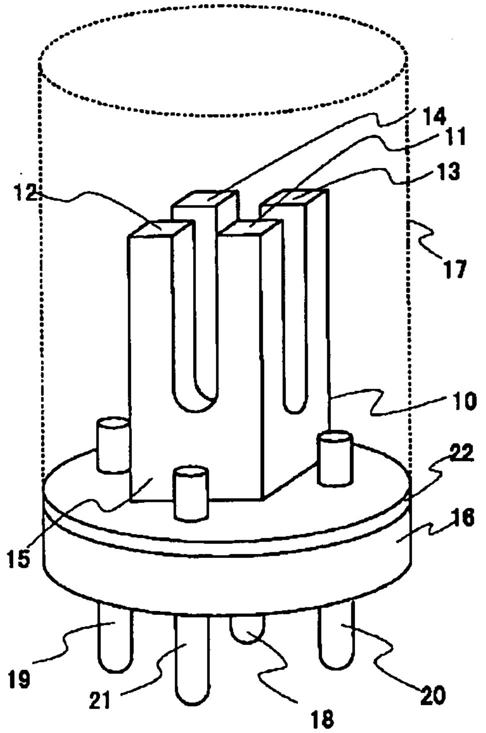

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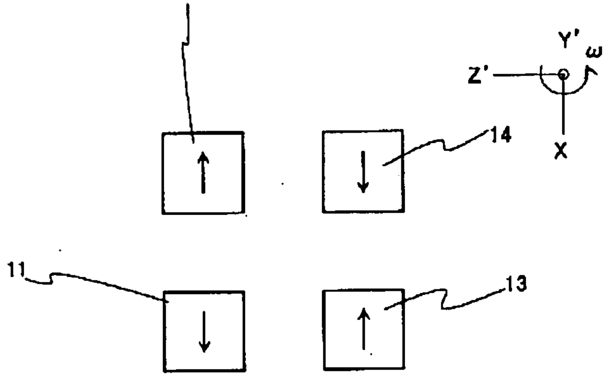

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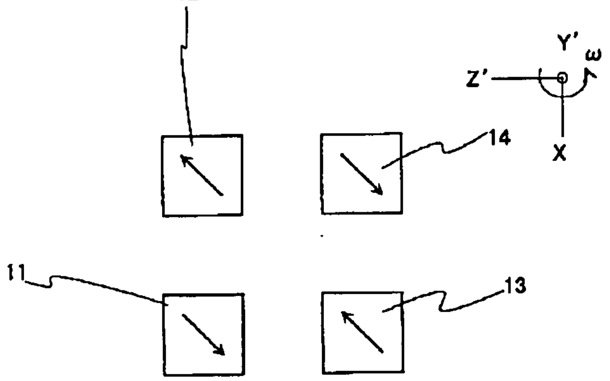
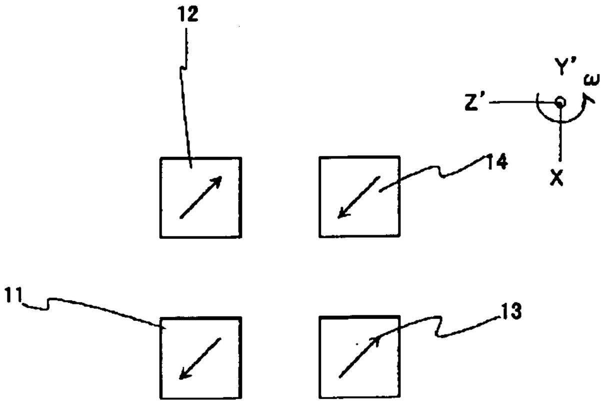
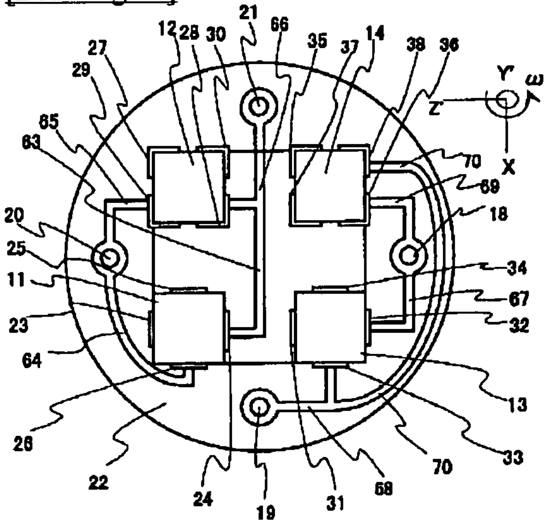


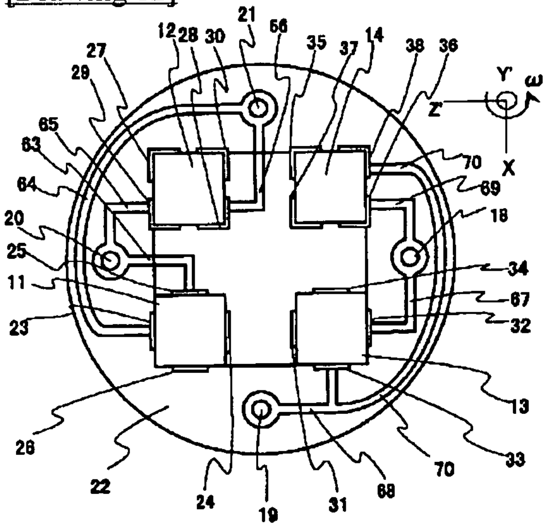
[Drawing 10]



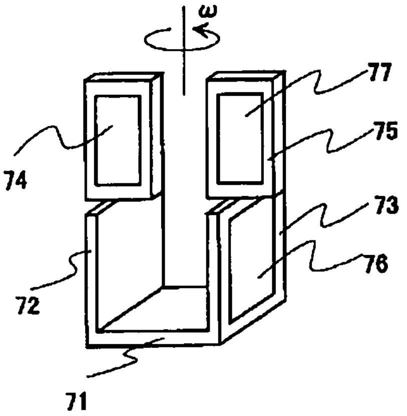
[Drawing 11]



[Drawing 12]



[Drawing 13]



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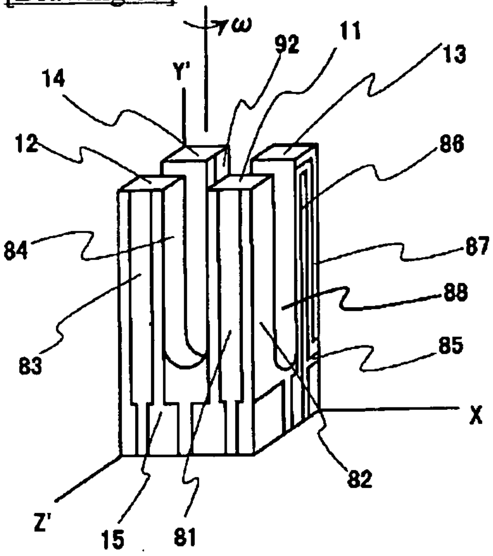
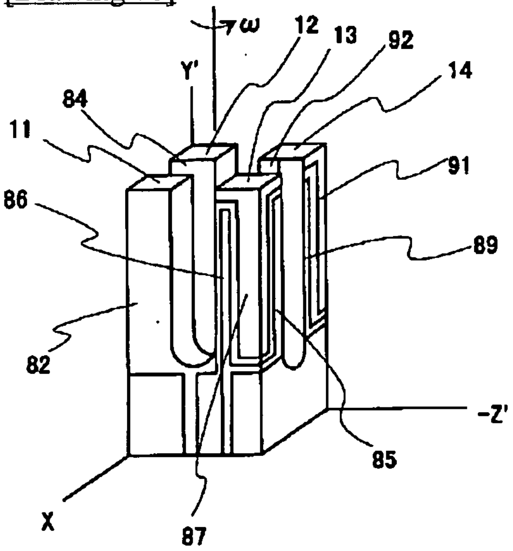
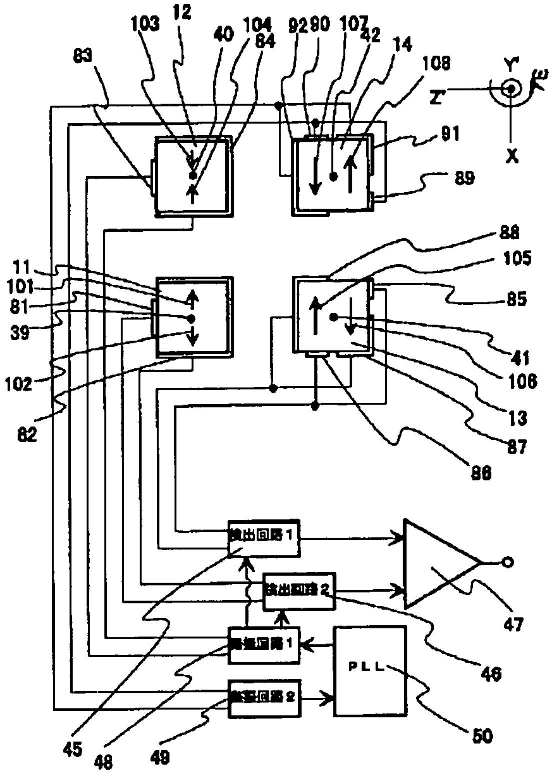


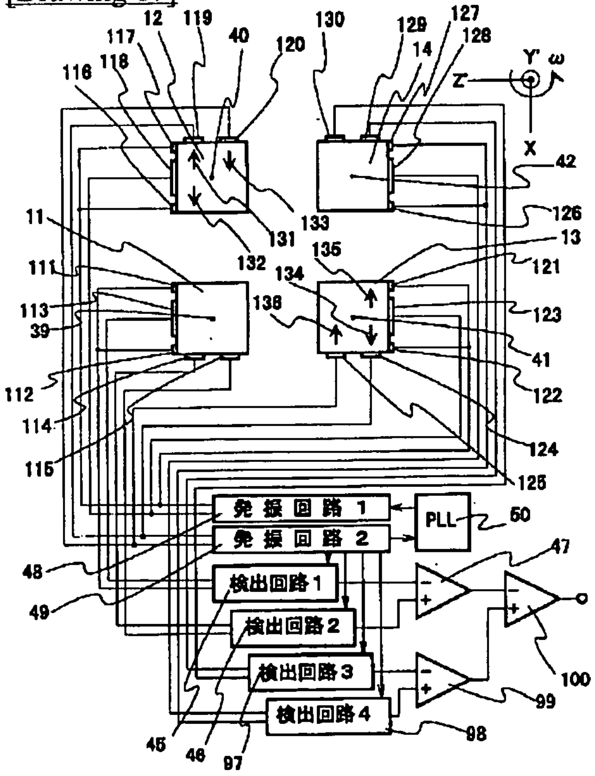
[Drawing 16]



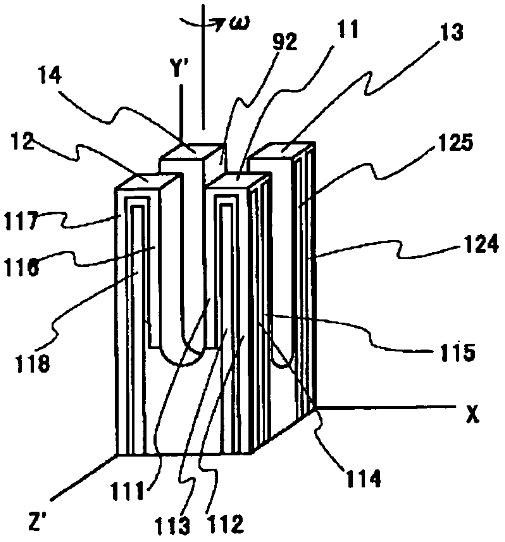
[Drawing 14]



[Drawing 17]



[Drawing 18]



[Translation done.]